PATENT SPECIFICATION (11) 1 452 377

(h)

1 452 377

(21) Application No. 15913/74 (22) Filed 10 April 1974 (19)

(23) Complete Specification filed 27 Feb. 1975

(44) Complete Specification published 13 Oct. 1976

(51) INT. CL.[2] B01D 3/32 C07C 7/04

(52) Index at acceptance

B1B 1 5N

C5E 5G

(72) Inventor NIGEL EDWARD HUMPHREY FEILDON

(54) IMPROVEMENTS RELATING TO DISTILLATION

(71) We, THE BRITISH PETROLEUM COMPANY LIMITED, of Britannic House, Moor Lane, London, EC2Y 9BU, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to fractional distillation, particularly the distillation of hydrocarbon fractions.

In the fractional distillation of hydrocarbon fractions the necessary heat may be supplied in a number of ways e.g., by preheating the feedstock in a furnace, by indirect heat exchange with steam, or by vapour recompression. All the methods have advantages and disadvantages, the final choice in any given situation depending on a variety of factors. In vapour recompression an overhead vapour griction is compression an overhead vapour fraction is compoint temperature of the fraction is sufficiently above the bubble point temperature of a distillation column stream to exchange its latent heat of condensation with the distillation column stream, e.g. in a reboiler. Such a system is effective only in the distillation of relatively narrow boiling fractions. If the difference between the temperatures of the overhead fraction and reboiler is too high, the required heat cannot be economically produced. In such circumstances the heat is normally supplied to the reboiler by the use of a furnace or steam or by heat exchange with another process stream.

The present invention adapts the vapour recompression system to work as a heat pump.

According to the present invention, a process of distillation comprises feeding a liquid to be distilled to a fractional distillation column, withdrawing an overhead fraction as vapour, compressing the overhead fraction with increase of temperature while maintaining it in the vapour phase, exchanging the latent heat of condensation of the pressurised overhead fraction with a distillation column stream, driving the compressor with a turbine using a vapour as mative fluid, exchanging the latent heat of condensation of the motive fluid exhaust vapour with a distillation column stream, and recovering one or more streams as product from the distillation column.

It will be seen, therefore, that the heat for the distillation is supplied partly by vapour recompression and partly from the motive fluid used to drive the compressor. The system is thus an integral, compression cycle heat pump system, the working fluid of the low temperature cycle being the overhead fraction from the distillation column and that of the high temperature cycle being the motive fluid vapour.

The motive fluid is preferably steam. The steam inlet temperature to the turbine is as high as possible, preferably at least 300°C and more particularly 350 to 550°C. The pressure and the heat released to the turbine are preferably such that the steam at the turbine outlet is at or near its dew point, this dew point being chosen to be as close as possible to the temperature to which the distillation column stream is to be heated. A suitable outlet temperature may be in the range 120—220°C. The inlet pressure of the turbine may be from 90 to 130 bars gauge. The condensed water may be recycled in standard manner.

Steam is the most convenient available motive fluid and as will be discussed in more detail hereafter can be usefully used for a variety of distillations. However, for maximum efficiency the motive fluid input temperature should clearly be as high as possible and the practical limit for steam is governed by the fact that the saturation pressure increases very rapidly above 300°C. The steam can, as indicated above, be super-heated above this temperature but the proportion of heat which can be supplied in this way is limited. The motive fluid may, therefore be a material having a higher critical temperature and hence a lower saturation pressure than steam at temperatures above 300°C e.g. mercury vapour.

The distillation column stream which is heat exchanged with the overhead vapour stream and the motive fluid vapour is preferably the reboiler stream, with separate reboilers being used for each vapour. As indicated above the reboiler temperature may be the range 120—200°C when using steam as the motive fluid, but may be appreciably higher with other motive fluids. With mercury vapour for example it may be up to 500°C. The overhead vapour stream temperature may be from 15—150°C with a temperature difference between it and the reboiler temperature of at least 15°C.

A particular use for the present invention may thus be in the distillation of hydrocarbon fractions boiling up to 200°C and particularly the distillation of petroleum fractions. Thus it may be used for the recovery of high octane iso-paraffins from naphtha. As is will known, the recovery of individual hydrocarbons from naphtha is an expensive and complicated process because of the closeness of the boiling points of the hydrocarbons and, sometimes, the number of hydrocarbons present. Columns for such separations have to have a large number of trays and high reflux ratios and it is important to have a high thermal efficiency if the process is to be economic. So-called super-fractionation was practised during World War II to provide high octane components for aviation gasoline, but declined in importance with the development of catalytic reforming. Legislation restricing the lead content of motor gasolines is now creating revived intereset in super fractionation.

The overhead stream after condensation may be returned at least in part to the column and will then be a reflux stream. Additional conventional reflux may also be provided if desired. The desired product may be the overhead stream and/or one or more side streams and/or the bottoms.

For the separation of one or more isoparaffins from naphtha the column may have from 70 to 120 trays and operate with molar rebux: distillate ratios of from 20:1 to 10:1. The column pressure may be from 0.5 to 2.5 bars gauge.

The invention is illustrated by the drawing accompanying the Provisional Specification showing a system for the separation of isopentane from a C_5 — 110°C fraction taken from an atmospheric crude oil distillation column.

In the drawing the C_5 — 110°C fraction is fed to a distillation column 1 through line 2. Iso-pentane is taken off overhead through line 3. Part of this isopetane is refluxed in conventional manner through line 4, condenser 5, drum 6, pump 7 and controller 8. The major part is, however, refluxed with recompression passing through line 9 to compressor 10 and thence to reboiler 11 where the compressed vapour is condensed. The liquid is further cooled as necessary in cooler 12 having a by-pass with controller 13 in it. It then passes through pressure control valve 14, part being returned through line 15 to the column and part being withdrawn as product through line 16 and flow-control valve 17.

Compressor 10 is driven by steam turbine 18 operating on a recycle system. Fresh feed water enters at 19 and fresh and recycled water is pumped by pump 20 through pressure control valve 21 to furnace 22 and the turbine 18. Exhaust steam is passed via line 23 to a second reboiler 24 where it is condensed and recycled to the furnace under the control of valve 25.

A bottoms fraction is withdrawn from the column via line 26 and is heat exchanged with the feed in exchanger 27.

In a specific example, column 1 contained 80 plates and operated at a column top pressure of 2.96 bars absolute. The iso-pentane vapour at 62°C was compressed to 13.44 bars absolute in compressor 10. The compressor outlet temperature was 120°C, this being the dew point of iso-pentane at 13.44 bars absolute. The liquid iso-pentane temperature at the outlet of reboiler 11 was 125°C and it was further cooled to 49°C by cooler 12.

Steam entered the turbine at 482°C and 103.4 bars absolute and left it at 127°C and 2.41 bars absolute. The steam was condensed in reboiler 24 without a significant temperature drop. The distillation column streams to reboilers 11 and 24 had inlet temperatures of 101°C and outlet temperatures of 190°C. The bottom fraction outlet temperature was 109°C and was heat exchanged with the feed to give a feed inlet temperature of 97°C.

A study of comparative systems showed that vapour recompression alone was not suitable since it could only provide 67% of the reboiler heat required. As compared with a system in which steam was used directly to supply reboiler heat, the present system was found to give a heat saving of 39%.

WHAT WE CLAIM IS:—

1. A process of distillation comprising feeding a liquid to be distilled to a fractional distillation column, withdrawing an overhead fraction as vapour, compressing the overhead fraction with increase of temperature while maintaining it in the vapour phase, exchanging the latent heat of condensation of the pressurised overhead fraction with a distillation column stream, driving the compressor with a turbine using a vapour as motive fluid, exchanging the

BEST AVAILABLE COPY

latent heat of condensation of the motive fluid exhaust vapour with a distillation column stream, and recovering one or more streams as product from the distillation column.

2. A process according to claim 1 wherein the motive fluid is steam.

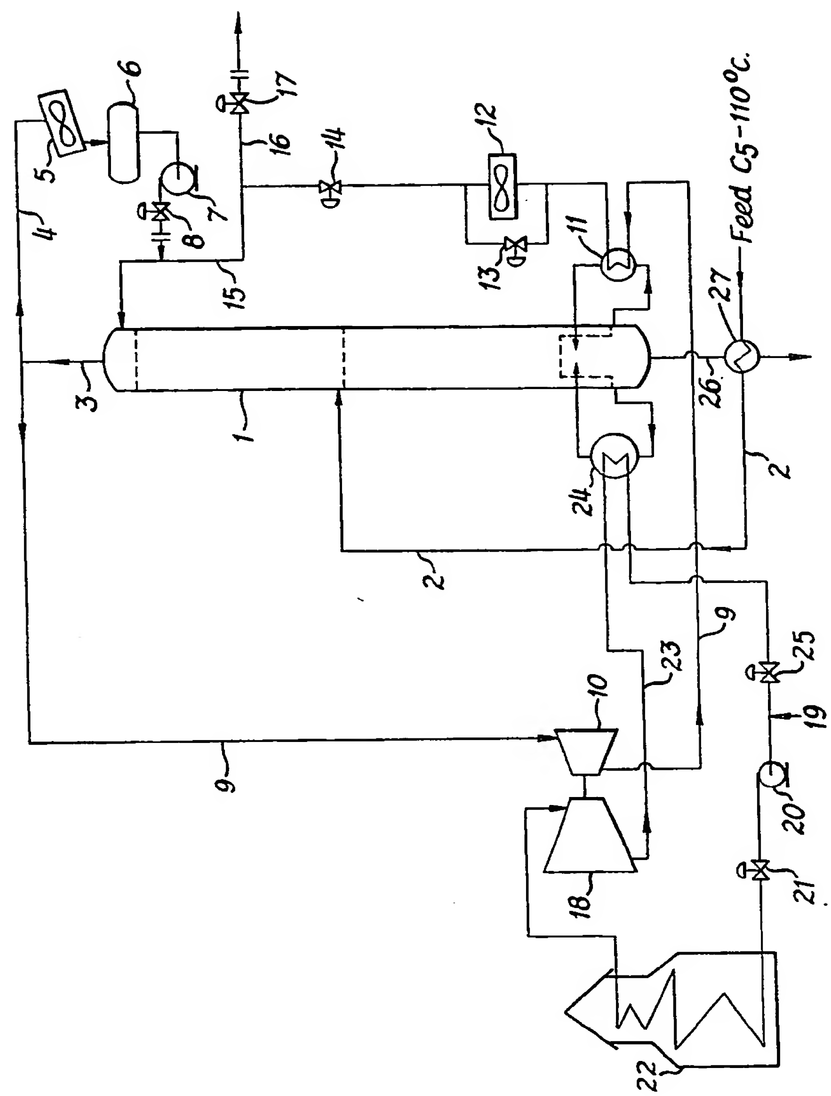
3. A process according to claim 1 wherein the motive fluid is mercury vapour.

4. A process according to any of the preceding claims wherein the distillation column stream which is heat exchanged with the overhead vapour stream and the motive fluid vapour is the reboiler stream, with separate reboilers being used for each vapour.

5. A process as hereinbefore described with reference to the drawing accompanying the Provisional Specification.

J. WOOLARD,
M. MACLEOD,
Agents for the Applicants.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1976.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY
from which copies may be obtained.


Feed C5–110°C.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27